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British Standard

# Lining of equipment with polymeric materials for the process industries

## Part 2. Specification for lining with non-sheet applied thermoplastics

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Revêtements intérieurs à base de polymères des matériels pour industries de procédés  
Partie 2. Revêtement par thermoplastiques non filmogènes — Spécifications

Auskleidung von betriebstechnischen Anlagen in der verarbeitenden Industrie  
mit Polymerstoffen

Teil 2. Thermoplastische Auskleidungen mit anderen Materialien als aus Folie

## Foreword

This Part of BS 6374 has been prepared under the direction of the Pressure Vessels Standards Committee. It is one of five Parts of a new standard that will supersede Parts 1, 4, 5 and 6 of CP 3003; the change in format arising from the fresh approach adopted to conform with developments in the associated lining technology.

The Technical Committee would like to acknowledge the contributions made by the Rubber and Plastics Research Association of Great Britain which supplied the initial draft document, and the users and the manufacturers on whose submissions the document was based.

The plastics linings referred to in this standard are used for a number of different duties, including protection against corrosive environments, prevention of contamination of products and surface finishes that do not foul easily or that can be cleaned easily. Specific linings are used for protection against abrasion or erosion.

The linings are applied using fluidized bed dipping, powder spray, plastisol or liquid dipping, dispersion spray or solvent spray techniques.

The thickness of linings based on these materials varies considerably with the particular plastic selected and ranges from 50  $\mu\text{m}$  to 10 mm. When the thickness of the lining is less than 400  $\mu\text{m}$  it is difficult to obtain linings which are pinhole free. Furthermore, even if linings as applied are free from imperfections, consideration has to be given to the possibility of damage in operation.

Before selecting a lining and the thickness at which it will be applied, some knowledge is required of the likely corrosion rate of the substrate and the mechanism of that corrosion. If the corrosion rate is low then the thickness of the lining is not a critical factor. If the corrosion rate is high and is due to simple solution of the metal, then it is not advisable to use thin linings because of the risk of severe corrosion through a pinhole. On the other hand, if a high corrosion rate is caused by an effect such as erosion/corrosion, then thin linings can be an effective barrier.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

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## Section one. General

### 1.1 Scope

This Part of BS 6374 specifies requirements for the lining of equipment for the process industries using non-sheet applied thermoplastics.

It includes requirements for the choice of lining and its application and also requirements for subsequent inspection of the lining and the rectification of faults.

NOTE 1. The materials considered include thermoplastic powders, plastisols and dispersions. Although not thermoplastics, fusion-bonded epoxy resin powders are included in this category since the same application techniques are used.

NOTE 2. The linings may be applied at the applicator's works or on site.

Requirements for design and fabrication of the equipment and the state of preparation necessary for the surfaces to be lined are specified in section two.

Requirements for storage, handling, transportation and installation of the lined equipment are specified in section eight.

This Part of BS 6374 does not apply to equipment manufactured in concrete.

NOTE 3. The titles of the publications referred to in this standard are listed on the inside back cover.

### 1.2 Definitions

For the purposes of this Part of BS 6374, the following definitions apply.

**1.2.1 plastic\*** (noun). A material that contains as an essential ingredient a high polymer and which at some stage in its processing into finished products can be shaped by flow.

NOTE 1. Elastomeric materials, which are also shaped by flow, are not considered as plastics.

NOTE 2. In some countries, particularly in the United Kingdom, the official position now is that it is a permitted option to use the term 'plastics' as the singular form as well as the plural form.

**1.2.2 resin\***. A solid, semisolid, or pseudosolid organic material that has an indefinite and often high relative molecular mass, exhibits a tendency to flow when subjected to stress, usually has a softening or melting range and, usually fractures conchoidally. In a broad sense, the term is used to designate polymer that is a basic material for plastics.

**1.2.3 thermoset\*** (noun). A plastic which, when cured by heat or other means, changes into a substantially infusible and insoluble product.

NOTE. This term includes both thermosetting plastics and thermoset plastics.

**1.2.4 purchaser†**. The organization or individual who buys the lined equipment for its own use or as an agent for the owner.

**1.2.5 fabricator†**. The organization or individual responsible for the fabrication of the equipment to be lined.

**1.2.6 applicator†**. The organization or individual responsible for the application of the lining.

**1.2.7 inspection authority†**. The body or association appointed by the purchaser (or owner) to check that the design, fabrication, and lining comply with this standard.

**1.2.8 lining**. A non-sheet applied thermoplastic or fusion-bonded epoxy coating which requires, where necessary, the equipment to be preheated and/or post-application stoving.

NOTE. Although in common usage the terms 'lining' and 'coating' are interchangeable, in this document 'lining' will be used.

**1.2.9 cure**. The chemical reaction resulting in the final polymerized product.

**1.2.10 pinhole**. A small defect in the lining that would permit corrosion of the substrate under the conditions for which the lining is designed.

NOTE. The word 'pinhole' is synonymous with 'holiday' and 'pore'.

**1.2.11 blister**. A gas or liquid filled cavity within the lining material or between the lining and substrate.

### 1.3 Exchange of information

Early consultation shall be arranged between all parties concerned with the application of this standard, to establish the following information which shall be fully documented. Both the definitive requirements specified in this standard and the documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

- (a) Design and fabrication details of the equipment to be lined and provision of drawings (see 2.2 and 2.3).
- (b) Details of gasket materials (see 2.2.9 and 2.2.10).
- (c) Details of the contents of the vessels or equipment, including trace materials (see 3.1.1(a)).
- (d) The design temperature (see 3.1.1(b)).
- (e) The design pressure (see 3.1.1(c)).
- (f) The details of any solids to be handled (see 3.1.1(e)).
- (g) The methods of heating and/or cooling (see 3.1.1(b)).
- (h) Cleaning methods, for example, water washing, solvent washing, boiling out or steaming (see 3.1.1(a)).
- (i) Where the lining work will be done.
- (j) Site conditions that may affect the work, for example availability of services.
- (k) Any special requirements for materials used in blast cleaning (see 4.1.3).
- (l) The type of material to be used for lining (see 3.1.1).
- (m) The minimum thickness of the lining and where applicable the maximum thickness (see 3.2.2).

\* These terms have been extracted from BS 1755 : Part 1.

† Where the words 'purchaser', 'fabricator', 'applicator' and 'inspection authority' occur in the text, they are intended also to include representatives of the purchaser, fabricator, applicator and inspection authority.

- (n) The provision of test pieces (see 3.2.1 and 5.2.3).
- (o) The maximum number of pinholes per square metre of surface if they are permitted (see 3.3 and 5.2.5).
- (p) The maximum and minimum allowable temperature that is required for the correct application of the lining (see 4.2).
- (q) The minimum temperature required during the curing of the lining (see 4.2).
- (r) Inspection techniques/procedures to be employed, acceptance levels and stages of inspection (see 5.1, 5.2 and 6.1).
- (s) Use of different materials for repair (see 7.1).
- (t) Handling, transport, storage and installation procedure (see 3.1.1(g) and 8.1.1 to 8.1.7).

## 1.4 Compliance

### 1.4.1 Fabricator

The fabricator shall comply with the following:

- (a) section two (see 1.3(a));
- (b) 5.1(a) and (b);
- (c) section eight as agreed in 1.3(t).

### 1.4.2 Applicator

The applicator shall comply with the following:

- (a) section three (but see 3.2.1);
- (b) section four;
- (c) 5.1(c), (d), (e) and (f);
- (d) section six;
- (e) section seven;
- (f) section eight as agreed in 1.3(t).

## Section two. Design, fabrication and surface finish of equipment to be lined

### 2.1 General

The basic design, fabrication and testing for mechanical reliability of the equipment to be lined shall be carried out to appropriate British Standards and shall comply with 2.2 and 2.3 before the lining operation commences.

### 2.2 Design of equipment to be lined

**2.2.1** Equipment to be lined shall be sufficiently rigid that there is no possibility of deformation which could result in damage to the lining during transportation, installation and operation. When stiffeners are required, they shall normally be applied to the unlined side of the equipment.

**2.2.2** The arrangements for the lifting of equipment shall be determined at the design stage.

**2.2.3** The design of all equipment shall allow for access during the preparation of the surface and application of the lining and for venting of fumes evolved during the operation.

In completely enclosed vessels there shall be at least one manhole that after lining complies with BS 470 and one additional branch of not less than 75 mm bore to permit adequate circulation of air.

NOTE. It is recommended that, where practicable, the minimum diameter of a manhole should be 600 mm.

**2.2.4** Riveted constructions shall not be used.

**2.2.5** Bolted joints shall be permitted only if they can be dismantled for lining.

**2.2.6** Surfaces to be lined shall be of a smooth contour.

**2.2.7** Discontinuities, crevices and sharp projections shall be avoided.

**2.2.8** Fittings that have to be installed after the completion of the lining process shall be designed to be lined or fabricated from materials that will not be affected by the process conditions.

**2.2.9** Normally all connections to lined parts of equipment shall be flanged. If for any reason screwed connections are required, then these parts shall be fabricated in corrosion-resistant materials.

**2.2.10** All nozzles and outlets shall be as short as possible, straight and flanged. Flange faces shall have a plain surface to allow the lining to continue over the face.

**2.2.11** Heating coils, immersion heaters and sparger pipes shall be installed after the completion of the lining process and shall be located so that no part is closer than 100 mm from a lined surface. In the case of nozzles through which heating coils, etc. enter equipment, a smaller clearance is permitted provided that the temperature of the pipe through the nozzle does not exceed 80 °C. In no case shall this clearance be less than 25 mm. Fluid introduced through sparger pipes or dip pipes shall not impinge directly on to the lining. External heating of equipment shall not be permitted without full consultation with the applicator of the lining.

**2.2.12** The design of pipework shall be such as to allow ready access to welds and bends for inspection and surface preparation.

NOTE. Systems made up from straight lengths with separate bends and tees meet this requirement (see figure 1).

Where pipes incorporating branches and bends are to be used, the diameter of the pipe and length of the fitting shall allow access for surface preparation and application of the lining. There shall be not more than one bend in any one pipe length (see figure 1(d)). The dimensions of such pipes shall form part of the requirements of 1.3(a).

### 2.3 Fabrication of equipment to be lined

**2.3.1** All welds shall be continuous on surfaces to be lined.

NOTE. Butt welds are preferred to fillet welds.

Stitch welding, spot welding and other non-continuous welding processes shall not be used.

**2.3.2** Weld surfaces shall be smooth. Some welding procedures provide surfaces of adequate smoothness but, in other cases surfaces shall be ground wholly or partly to remove weld ripples. The grinding process shall be done so that the remaining weld does not have sharp edges.

**2.3.3** Welding procedures shall be chosen to avoid porosity on the side of the weld to be lined.

NOTE. It is preferable that capping runs are applied to the lining side in order to minimize this effect.

All welds shall be free from the following surface defects:

- (a) undercutting;
- (b) cracks;
- (c) porosity;
- (d) any other type of surface cavity;
- (e) lack of fusion.

Weld defects that are exposed either on initial inspection or after blast cleaning shall be repaired.

Repairs shall be by grinding or by welding (with or without subsequent grinding) provided that the requirements for equipment design and fabrication are met.

**2.3.4** Weld profile details shall be generally in accordance with figures 2 to 6.

NOTE. Incorrect details are also illustrated.

**2.3.5** Filler materials, such as resin, putties, fillers and low melting point solders and brazes, shall not be used.

**2.3.6** Before the equipment is passed for lining, all attachments to be made by welding, for example lagging cleats and lifting lugs, shall be complete.

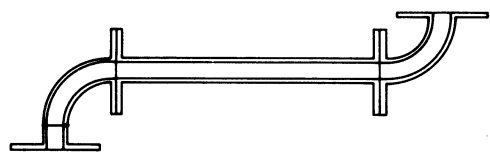
**2.3.7** All drilling shall be completed before the equipment is passed for lining.

**2.3.8** All changes in contour shall be finished to a radius of not less than 3 mm.

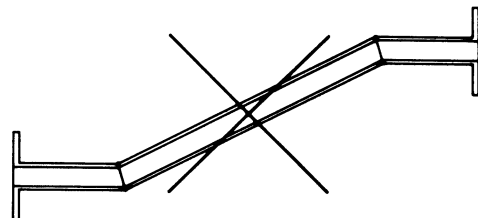
**2.3.9** All slag, anti-spatter compounds or similar materials shall be removed.

All weld spatter shall be removed by chipping and/or grinding.

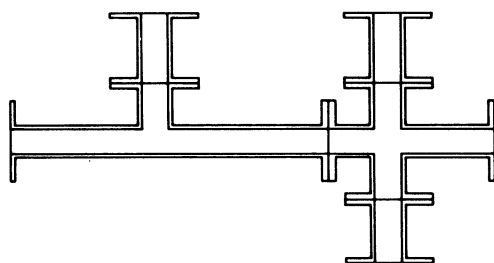
**2.3.10** Surface defects such as scores, pitting and rolling defects, shall be removed by grinding, or where necessary repaired by welding provided that the requirements of design and construction are met.



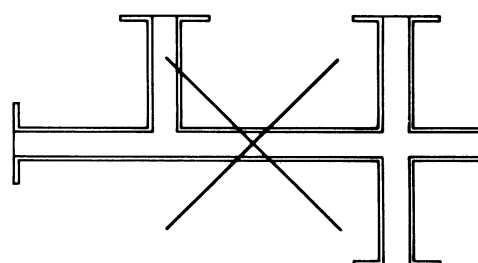
(a)



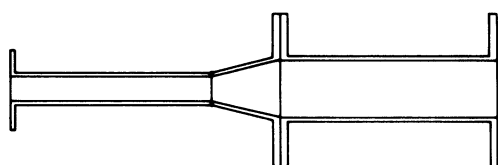
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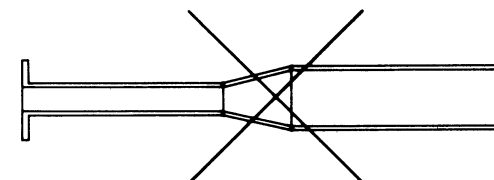
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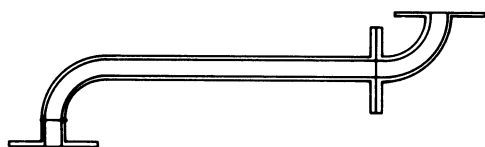
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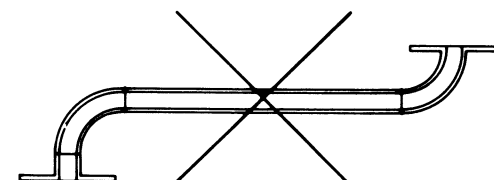
(c)



(g)



(d)



(h)

NOTE. The details shown in (a), (b), (c) and (d) are permissible; those shown in (e), (f), (g) and (h) are not permissible.

Figure 1. Pipework details

